AL/EQ-TR-1994-0038

ARMSTRONG LABORATORY

ZERO DISCHARGE PROJECT

G.A. Hulet, B.V. Heyrend, T.M. Butikofer,
A.J. Smith, A.G. Chambers, S.N. Brown

Idaho National Engineering Laboratory
EG&G Idaho, Inc.,
P.O. Box 1625
Idaho Falls, Idaho 83415-2050

ENVIRONICS DIRECTORATE
139 Barnes Drive, Suite 2
Tyndall AFB FL 32403-5323

November 1995

Final Technical Report for Period August 1994 - November 1995

AIR FORCE MATERIEL COMMAND
TYNDALL AIR FORCE BASE, FLORIDA 32403-5323

NOTICES

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any Agency thereof, nor any employees, nor any of their contractors, subcontractors, or their employees, make any warranty, expressed or implied, completeness, or usefulness of any privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency, contractor, or subcontractor thereof. The views and opinions of the authors expressed herein do not necessarily state or reflect those of the United States Government or any agency, contractor, or subcontractor thereof.

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This technical report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS) where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

Ray Anthony A

RAY A. SMITH, 1 Lt, USAF, BSC
Project Manager

Michael G. Katona

MICHAEL G. KATONA, PhD
Chief Scientist, Environics Directorate

Albert Nat Rhodes III

ALBERT N. RHODES, Major, USAF
Chief, Environmental Compliance

Neil J. Lamb

NEIL J. LAMB, Colonel, USAF, BSC
Director, Environics Directorate

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE Nov. 30, 1995

3. REPORT TYPE AND DATES COVERED Final

4. TITLE AND SUBTITLE

Zero Discharge Project

5. FUNDING NUMBERS

DE-AC07-76ID01570

6. AUTHOR(S)

G.A. Hulet, B.V. Heyrend, T.M. Butikofer
A.J. Smith, A.G. Chambers, S.N. Brown

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Idaho National Engineering Laboratory
EG&G Idaho, Inc., P.O. Box 1625
Idaho Falls, Idaho 83415-2050

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Armstrong Laboratory
139 Barnes Drive, Suite 2
Tyndall AFB, FL 32403

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

AL/EQ-TR-1994-0038

11. SUPPLEMENTARY NOTES

Prepared for the United States Air Force through the U. S. Department of Energy

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Unlimited Distribution

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This report describes the Zero Discharge Project. The project developed computer software that would assist with eliminating hazardous waste discharges from the Air Force Air Logistics Centers (ALCs). The software, called Zero-Discharge Plan, was based on a manually prepared plan. Phase I of the project, proof of concept, used Toolbook®, Runtime Version 1.5 from Assymetrix Corporation to create an easy-to-use software package that could summarize ALC hazardous waste discharge data and link it with information from projects aimed at reducing those wastes. The Phase II effort applied the ideas of the Phase I work using Microsoft Corporation's Foxpro 2.5 for Windows™, a software development kit with database capabilities. This report summarizes the accomplishments of Phase I and describes the Phase II software, data-gathering, and data reduction efforts and methods.

DTIC QUALITY INSPECTED 3

14. SUBJECT TERMS

Zero Discharge Project (U)
Hazardous Waste Reporting (U)
Hazardous Waste Planning (U)

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

(The reverse of this page is blank)

PREFACE

This report was prepared by the Idaho National Engineering Laboratory, Idaho Falls, Idaho, under U.S. Department of Energy contract DE-AC07-761DO1570 for the Armstrong Laboratory Environics Directorate (AL/EQ), Suite 2, 139 Barnes Drive, Tyndall Air Force Base, Florida 32403-5319.

This report describes the Zero Discharge Project. The project developed computer software that would assist with eliminating hazardous waste discharges from the Air Force Air Logistics Centers (ALCs). The software, called Zero-Discharge Plan, was based on a manually prepared plan. Phase I of the project, proof of concept, used Toolbook®, Runtime Version 1.5 from Assymetrix Corporation to create an easy-to-use software package that could summarize ALC hazardous waste discharge data and link it with information from projects aimed at reducing those wastes. The Phase II effort applied the ideas of the Phase I work using Microsoft Corporation's Foxpro 2.5 for Windows™, a software development kit with database capabilities. This report summarizes the accomplishments of Phase I and describes the Phase II software, data-gathering, and data reduction efforts and methods.

The project was initiated under Lt Phillip P. Brown and completed under Lt Ray A. Smith of AL/EQS at Tyndall AFB, Florida.

(The reverse of this page is blank.)

EXECUTIVE SUMMARY

A. OBJECTIVE

This report describes the United States Air Force Zero Discharge Project, including the Phase I proof-of-concept effort and the Phase II full-scale development work. The project was sponsored initially by the Air Force Civil Engineering Support Agency (AFCESA) and later by Armstrong Laboratory after a reorganization of project management responsibilities. The objective of the project was to develop computer software that would serve as a planning tool to assist in the elimination of hazardous waste discharges from the Air Force Air Logistics Centers (ALCs). This software was to be called the Zero-Discharge Plan (ZDP) and was based on a manually prepared plan that had been created previously by AFCESA's Civil Engineering Laboratory.

B. BACKGROUND

The Air Force operates five ALCs tasked with maintaining the readiness of most of the major Air Force weapon systems. The hazardous wastes generated by these ALCs represent approximately 75 percent of the total Air Force hazardous discharges. The Air Force has made a commitment to significantly reduce the hazardous waste that it generates, and has allocated significant resources to achieve this goal. The Air Force Civil Engineering Support Agency (AFCESA) drew on its experience in waste minimization programs and developed a basic draft document called the "Zero-Discharge Plan." The development of that document was an initial attempt at producing a systematic method for prioritization of funding and coordination with other organizations to leverage funding and prevent duplication of effort. That work pieced together a picture of the effort required to approach the goal of Zero-Discharge. The INEL was tasked with taking this basic document and converting it into an easy-to-use software system that could take in current hazardous waste problems, couple that information with efforts to alleviate those problems, and provide a view of the progress toward hazardous waste elimination. Areas requiring more concentrated effort would become apparent, giving direction to future allocation of resources. The comprehensive plan developed by this project was to help the Air Force direct and execute the RDDT&E activities necessary to reduce the ALC hazardous waste discharges to zero in the next decade.

C. SCOPE

The work scope of the Zero-Discharge Project, as described in the statement of work, was divided into two phases, with Phase II building on the results of Phase I. Phase I proved the feasibility of a computerized Zero-Discharge Plan based on the concept of an easy-to-use software package that summarizes ALC waste discharge and project information. The principal thrust of Phase I was to verify and validate the existing Air Force Zero-Discharge Plan and make it presentable to a variety of audiences with differing technical backgrounds. The current waste-minimization needs at the ALCs were to be identified, compared with existing waste-reduction projects, and compiled in an easily retrievable computer software program. The software program was to be used for presentations of the Zero-Discharge Plan.

In Phase II, the Zero-Discharge Plan was to be further developed to provide greater detail concerning: the needs of the ALCs, realizable cost benefits attributable to each waste minimization effort and target area, estimates for RDDT&E program costs, and areas where efforts could be integrated and leveraged with DOE-OTD and other agencies. Work was to continue to refine the software as a presentation tool.

D. METHODOLOGY

The Phase I proof-of-concept work used Toolbook®, Runtime Version 1.5 from Assymetrix Corporation to create an easy-to-use software package that could summarize ALC hazardous waste discharge data and link it with information from projects aimed at reducing those wastes. Data samples were collected from the ALCs and loaded into the system. The resulting product demonstrated the concept's feasibility, but was limited in its capacity to handle data. Tookbook® does not have database capabilities to handle the huge quantities of data that the full-scale ZDP would face.

The Phase II full-scale effort applied the ideas of the Phase I work using Microsoft Corporation's Foxpro 2.5 for Windows™, a software development kit with database capabilities. A software package was created that included modules with summaries of waste discharges and projects linked through the processes that created the wastes and the hazardous chemical constituents in the wastes. Waste and project data were gathered from the ALCs and additional project information was obtained from Wright and Armstrong Laboratories and from the Department of Energy. These data were summarized and loaded into the ZDP database. Because of difficulties in obtaining some of the data, the database is not complete. The missing data may be added later, if the responsible Air Force agencies provide it.

This report provides a summary of the Phase I accomplishments, a detailed description of the Phase II software, and an account of the Phase II data-gathering and data-reduction efforts and methods.

E. CONCLUSIONS

The Air Force is trying to reduce discharges of hazardous wastes. The goal of zero hazardous waste discharge may not be reached soon, but great strides can be made toward that goal with carefully planned and prioritized projects and efficient use of the budgets available to make the needed changes. The Zero-Discharge Plan will be one tool available for those responsible for planning, funding, and executing the changes. Its effective use in conjunction with such tools as WIMS-ES and AQUIS will assist the Air Force in selection projects, allocating resources, and reaching the goal of zero discharge

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

SECTION I
INTRODUCTION

A. OBJECTIVE

The objective of the Air Force Zero-Discharge Project was to develop a planning document, in the form of a software product, that will be used to direct activities leading to the ultimate goal of zero hazardous waste discharge to the environment from the Air Force Air Logistics Centers (ALCs). EG&G Idaho, Inc. personnel from the Idaho National Engineering Laboratory (INEL) were requested to develop a plan that would provide an organized, systematic method to establish research, development, demonstration, testing and evaluation (RDDT&E) activities in support of waste minimization in ALC operations. As part of the plan, a waste minimization roadmap was developed to summarize the efforts aimed at eliminating wastes from specific processes or eliminating a specific type of waste from a number of processes. This roadmap provides a broad-based picture of the RDDT&E activities to help prioritize additional efforts and increase efficiency in acquiring, directing and managing resources. The Department of Energy (DOE) contributed information on RDDT&E projects within the DOE complex aimed at wastes similar to those at the ALCs. Integration of the plan with DOE allows for coordinating efforts and pooling resources to achieve the maximum benefit from allocated resources.

B. BACKGROUND

The Air Force operates five ALCs tasked with maintaining the readiness of most of the major Air Force weapon systems. The hazardous wastes generated by these ALCs represent approximately 75% of the total Air Force hazardous discharges. The Air Force has made a commitment to significantly reduce the hazardous waste that it generates, and has allocated significant resources to achieve this goal. The Air Force Civil Engineering Support Agency (AFCESA) drew on its experience in waste minimization programs and developed a basic draft document called the "Zero-Discharge Plan." The development of that document was an initial attempt at producing a systematic method for prioritization of funding and coordination with other organizations to leverage funding and prevent duplication of effort. That work pieced together a picture of the effort required to approach the goal of Zero-Discharge. The INEL was tasked with taking this basic document and converting it into an easy-to-use software system that could take in current hazardous waste problems, couple that information with efforts to alleviate those problems, and provide a view of the progress toward hazardous waste elimination. Areas requiring more concentrated effort would become apparent, giving direction to future allocation of resources. The comprehensive plan developed by this project was to help the Air Force in direct and execute the RDDT&E activities necessary to reduce the ALC hazardous waste discharges to zero in the next decade.

AFCESA perceived a need for a presentation tool that could be used to brief a variety of groups on the hazardous waste problem and the plans to alleviate it. The targeted groups were technical-level briefings, mid-level briefings, and upper-level management summations. The presenter was to use a laptop computer and associated projection equipment for the briefings, eliminating the need for 35-mm and overhead slides. After the project had

started, the Air Force responsibility for oversight was shifted to the Armstrong Laboratory Environics Directorate which remained at Tyndall AFB.

C. SCOPE

The work scope of the Zero-Discharge Project, as described in the statement of work, was divided into two phases, with Phase II building on the results of Phase I. Phase I proved the feasibility of a computerized Zero-Discharge Plan based on the concept of an easy-to-use software package that summarizes ALC waste discharge and project information. The principal thrust of Phase I was to verify and validate the existing Air Force Zero-Discharge Plan and make it presentable to a variety of audiences with differing technical backgrounds. The current waste-minimization needs at the ALCs were to be identified, compared with existing waste-reduction projects, and compiled in an easily retrievable computer software program. The software program was to be used for presentations of the Zero-Discharge Plan.

In Phase II, the Zero-Discharge Plan was to be further developed to provide greater detail concerning: the needs of the ALCs, realizable cost benefits attributable to each waste minimization effort and target area, estimates for RDDT&E program costs, and areas where efforts could be integrated and leveraged with DOE-OTD and other agencies. Work was to continue to refine the software as a presentation tool.

Preparation of a poster board describing the Zero-Discharge Plan was initially included in the statement of work for Phase II. However, the Air Force project manager eliminated that requirement and directed that the resources involved should be allocated toward the software and database development.

SECTION II
PHASE I

As described, the objective of Phase I was to prove the concept of Zero-Discharge Plan software that could summarize project and hazardous waste information and provide access to that information in an easy-to-use package. This section describes the software developments of Phase I, the data gathering activities, and the final results of combining the available data into the software.

A. SOFTWARE DEVELOPMENT

Several design criteria were selected on which the software would be based. These criteria included the following:

- The software should be easy to use, requiring minimal instruction to become proficient in extracting or loading the desired information.
- The software should be written for an IBM Personal Computer or compatible unit.
- The software should be written to use a Windows-compatible mouse or other pointing device.
- The software screens should be laid out in a form that would be appropriate for projection during a presentation.

Using these criteria, Toolbook®, Runtime Version 1.5 from Assymetrix Corporation was selected as the development package for the software. At the time this selection was made, no software development tools were available that had database capabilities. Project personnel decided that the conceptual version of the Zero-Discharge Plan could be created easily from this basic Toolbook package. This initial version of the software effectively demonstrates the feasibility of a computerized Zero-Discharge Plan, but is limited in its data-handling capabilities. All of the data essentially had to be hardcoded into the system, because Toolbook does not operate as a database. This limitation eliminated Toolbook as a candidate for use in developing the full-scale system.

1. Data Structure

The Phase I conceptual version of the Zero-Discharge Plan has information arranged in a hierarchy based on levels of summary. Data are organized by each ALC and also for the Command. At each level, information can be accessed vertically, affecting the level of summary, or laterally, comparing a given level of detail between the ALCs and the Command.

This software, with its accompanying operating instructions, was successfully demonstrated for the Air Force at the completion of Phase I.

2. Data-Gathering Effort

The Air Force Project officer requested each of the ALCs to provide information about the hazardous wastes generated there and the projects under way to reduce or eliminate the creation and discharge of those wastes. The

ALCs were to provide descriptions of hazardous-waste-generating processes, amounts of waste generated, disposal costs of waste streams, and projects funded or planned to target the waste streams or processes. The response was limited, but enough information was gathered to provide a sample data set representative of the material that would be available in a full-scale database. This data set was coded into the software, giving a good picture of how the Zero-Discharge Plan would work if a complete data set were present.

B. PHASE I HARDWARE AND SOFTWARE REQUIREMENTS

The following sections describe the hardware and software required to operate the Phase I Zero-Discharge System.

1. Phase I Hardware Requirements

The hardware required to operate the Phase I version of the Zero-Discharge System are the following:

- IBM Personal Computer or compatible with 286 or higher processor
- Random access memory - 1.5 megabytes minimum
- 2.0 megabytes recommended
- Hard disk drive - 10 megabytes
- Graphics adapter card (VGA, EGA, 8514, Hercules, or other compatible card
- Windows-compatible mouse or other pointing device

2. Phase I Software Requirements

The software requirements for operating the Phase I Zero-Discharge System are the following:

- Microsoft Windows, version 3.0 or higher
- Disk Operating System 3.1 or higher

C. PHASE I CONCLUSIONS

The software developed in Phase I effectively demonstrated the feasibility of the concept of a computerized plan to eliminate discharges of hazardous wastes at the ALCs. During its demonstration to the Air Force, it proved to be an efficient briefing tool, showing its value in summarizing the ALC waste discharge problems and coupling those problems with the current efforts to solve them. Problem areas with no current solutions became readily apparent. The Phase I software demonstration proved the worth of continuing with the development of the full-scale Zero-Discharge Plan.

One item that became apparent during the development and demonstration of the Toolbook version of the Zero-Discharge Plan was the critical need for relational database capabilities. Without these capabilities the information-providing capacity of the system was extremely limited. An additional

vulnerability of the system was the vital role of the ALCs cooperation in making the plan successful. Without considerable ALC help in providing the information for the database, the full-scale Zero-Discharge Plan would fail, regardless of capability of the software.

SECTION III
PHASE II SOFTWARE DEVELOPMENT

The Phase II work was divided into two main thrusts: (1) development of the ZDP software package and (2) gathering and reducing the baseline information for the database. This section describes the software development effort and the final software product.

A. SELECTION OF THE SOFTWARE DEVELOPMENT PACKAGES

Coding the ZDP software first required that a basic software package be selected that would serve as the foundation for the database and would provide the infrastructure for the database and its auxiliary capabilities. The requirements for the selection of the development software package were as follow:

- Graphical user interface capability
- Relational database capability
- "User-friendly"
- Flexibility in reporting

While the time the candidate software development packages were being reviewed, several different packages were considered. Some packages reportedly had the needed capabilities; however, they were new on the market and project personnel had no proof that they worked according to their product specifications. Microsoft Corporation's Foxpro 2.5 for Windows ™ package has continually proven to be an excellent product for software development. It provides screen generators, query building capabilities, and other tools that save the developer a significant amount of time. Some of the other packages analyzed did not provide these tools.

Through the use of Microsoft Corporation's (MS) Windows 3.1 for DOS™ and Foxpro 2.5 for Windows™, the application would be able to provide a "point and click" graphical interface to the user. The screens and menus could be controlled by button and icon functionality. Additionally, Foxpro is a database software package, which met a critical requirement for the new system to have relational database capabilities. Also, Foxpro is considered to be a "user-friendly" software package because of its graphical user interface capabilities and its ease of operation for the end user. Finally, Foxpro provides a great deal of flexibility in reporting. The reporting packages chosen were R&R Report Writer 2.0 for Windows™, and Graphics Server SDK 2.2™. Textual reports were developed with R&R because of the direct linking that R&R provides to the Foxpro databases and because it was no additional cost to the user. The report library is packaged for the end user as part of the deliverable. Graphical reports were developed with Graphics Server SDK. Graphics Server SDK also provides direct linking to the Foxpro databases and enhances the reporting capability by providing graphical representations of the data through the use of bar charts, stacked bar charts, and pie charts.

B. SOFTWARE DEVELOPMENT DOCUMENTS

The Institute of Electronic and Electrical Engineers (IEEE) software development standards require that a Software Requirements Specification (SRS), and a Software Design Description (SDD) be developed for a system such as the ZDP. Additionally, a test plan and individual test cases are necessary to ensure that the requirements of the system are met. These documents were prepared by IEEE standards and were used as the guidelines for the software development.

The first step in the Phase II development was to gather the system requirements, then document them in the SRS. This document provides specific details on what each screen is to display, what is to be included in each report, the software and hardware requirements for the end user to operate the ZDP, and the overall objective of the software. The detailed requirements were then developed into the system design and documented in the SDD. This document tells how the software will meet the requirements of the SRS. The design is a traceability matrix to the SRS to ensure that each design detail has met a specific requirement as outlined in the SRS. Project personnel had selected the software development kit prior to the gathering of system requirements. The design of the software had to fall within the realm of capabilities for Foxpro 2.5™.

Approximately midway through development, an independent person, i.e., someone other than the software engineers, took the SRS and wrote the Test Plan and Test Cases for the system. When the document was in final form, it was reviewed and approved by a Software Quality Assurance Specialist indicating that the document met the IEEE standards and provided a traceability matrix to the requirements of the system.

C. SOFTWARE VERIFICATION TESTING

When the software coding was complete, the software was loaded from the development machine onto a stand-alone machine with all of the required hardware and software for the ZDP. The independent tester followed the sequence of the testing as outlined in the written test cases and tested the system. As problems were encountered, they were documented by the tester, communicated to the Project Leader, and retested when the appropriate modifications had been completed by the software engineers. This process continued until all noted problems had been corrected and retested.

When the system was thoroughly tested, the Test Plan and Test Cases were approved by the tester, the project leader, and the project manager as acceptance of the system.

D. PHASE II SOFTWARE STRUCTURES AND CAPABILITIES

When data were being collected for the ZDP, the USAF did not have a means of sharing detailed process waste information among the ALCs. The ZDP will provide a tool to the ALCs and Air Force Laboratories to help plan research and development efforts toward the goal of zero discharge of hazardous waste by sharing the information contained in the database. It will also provide a source of information about Air Force-sponsored projects at other bases and Department of Energy (DOE) waste-elimination projects.

To provide an organized structure for accessing the data in the ZDP, the software was divided into six modules. They are: Plan Description, Waste Discharge Information, Project Information, Reports, Data Input/Periodic Data Load, and Maintenance. These modules will be described in the following subsections.

1. Plan Description Module

The Plan Description module displays textual information that describes the objective of the ZDP, problems and solutions of waste discharge, and textual and graphical information that provides an overview on how waste is generated at the ALC sites. The contents of this module can be modified through the Data Input/Periodic Data Load module to provide the capacity to tailor briefings and presentations to a specific audience.

2. Waste Discharge Information Module

The Waste Discharge Information module displays process waste information from four different levels; by combined ALC, by specific ALC, by process, and by chemical constituent. Each of these levels has been allocated a subsection of the Waste Discharge Information Module. The system allows navigation from the Combined ALC information to the Specific ALC information, from the Specific ALC information to the Process information, from Process to Waste Stream and from Waste Stream to Chemical Constituent information.

The data for the Waste Discharge Information module are stored according to the calendar year in which the waste was generated. Users select the year of the data they wish to view upon entering this section.

a. Combined ALC Level

The Combined ALC level allows the user to view waste data for all of the ALCs. The information displayed at the Combined ALC level include the total waste quantity and the total disposal cost for each ALC. The user can select a specific ALC and view the process data for that ALC. The process data include wastestream names, the quantity of waste disposed for that process, the average unit cost of disposal, the total cost of disposal, and a recycle flag that indicates which wastestreams are sent for recycling. The user can also view the description for a wastestream, the quantity of waste for that wastestream, and the disposal cost for each chemical constituent for the wastestream.

b. Specific ALC Level

The ALC level allows the user to view processes, total waste quantity, and total disposal costs for a process at a specific ALC. The user can select a process at an ALC and view the following information: wastestream name, quantity, unit cost of disposal, total cost of disposal, and a recycle flag. The user can also view the description for each waste stream, the quantity of waste contaminated by each chemical constituent for that wastestream, and the cost of disposing of that material.

c. Process Level

The process level allows the user to view the wastestream name, quantity, unit cost of disposal, total cost of disposal, and a recycle flag for a process for a selected ALC. The user can also view the description for each wastestream, and the disposal cost for and the quantity of waste contaminated by each chemical constituent for the wastestream.

d. Chemical Constituent Level

The chemical constituent level allows the user to select a specific chemical constituent and view the total quantity of waste contaminated by that chemical constituent at each ALC. The user can select an ALC and a process to view the total quantity of waste contaminated by each chemical constituent.

3. Project Information Module

The Project Information module allows the user to view project information from four different levels; Combined ALC, Specific ALC, Process and Chemical Constituent. The system allows navigation from the Combined ALC information to Specific ALC data, and from the Specific ALC information to Process and to the Chemical Constituent data. The user selects the year of the data they wish to view upon entering this section.

a. Combined ALC Level

The Combined ALC level allows the user to view project data for all ALCs. The information available at the combined ALC level includes an ALC/Lab designator (Location), the total expected cost for the project, the expected benefits, and the percent that the project is expected to reduce the ALC's discharge rate for hazardous waste. The number of projects for each ALC is calculated and displayed. The expected cost and expected benefits are summed and displayed for each location. The percent reduction of the combined discharge rate for the ALCs is calculated and displayed. The user can also select an ALC name and view project data for the selected ALC.

b. Specific ALC Level

The ALC level allows the user to view projects titles, expected costs, expected benefits, the percent reduction of the total discharged wastes, and the payback period for each project. The user can select a project at an ALC and view other detailed project information that includes start date, cost/funding source, description, contact name and phone number, a research and development flag, and the completion date.

c. Process Level

The process level allows the user to select a process and view all of the projects for that process. The system displays the process name, ALC/Lab (Location), project name, expected cost, expected benefit, percent reduction of total ALC hazardous wastes, and the payback period for the project. The expected cost and expected benefit are summarized and displayed for each location.

d. Chemical Constituent Level

The chemical constituent level allows the user to select a chemical constituent and view the number of projects aimed at reducing wastes contaminated by that chemical, and see the total weight of those wastes for that year at that ALC. The user can select a chemical constituent and view all of the projects for that chemical and the location for each project. The user can also view the detailed project information for the selected chemical constituent, ALC and project.

4. Data Input/Periodic Load Module

The Data Input/Periodic Load module provides the capability to allow ALCs to load their own data from other sources (computers) or to manually input the data. The four options for the Data Input/Periodic Load module are to: input/edit the periodic data manually, input the periodic data automatically, copy one dataset to another, and prepare the periodic data for output.

a. Input/Edit Data Manually

The input/edit data manually option allows the user to add, delete, edit, or view the Chemical Constituent, Plan Description, Project Information, and Waste Discharge data one record at a time through the respective detail screens.

b. Input Data Automatically

The input data automatically option allows the user to add data automatically to the system by loading in entire files of Chemical Constituent, Project Information or Waste Discharge data. The automatic data load utility provides different options for different users, for example the Load Records for Central Repository may only be accessed and used by the System Administrator, or Central Repository of the entire ZDP. The Load New Records option may only be utilized by each ALC.

The chemical constituent, project information and waste discharge data must be in ASCII format to be loaded automatically. The year and name(s) of the file(s) to be loaded must also be entered.

c. Copy One Dataset to Another

In an effort to aid the user in preparing his/her periodic data to be sent to the central repository, the system provides the capability to copy data (waste discharge, project and chemical constituent information) from one year to another. The year to copy data from and to must be specified.

d. Prepare Periodic Data Files

Until a method is developed to obtain the required information from a centralized source, each of the ALCs/Labs will be asked to send their data on a periodic basis to the central repository. The year, contact information, and name of the file to output must be entered. The output file can be waste, project, or chemical data.

The system checks the data being offloaded for records with missing key information. Depending on the files being offloaded, the key information varies. Overall, it will be the year, location, process name, waste stream or project name, and chemical constituent name (for chemical constituent data only). If incomplete records are found, the system displays a listing of the incomplete records with key information displayed (key fields). The incomplete records are displayed for editing. After the data have been modified, the information may be output again. After the data has been successfully offloaded onto the diskettes, the user will send the storage media to the central repository for incorporation into the central database. The repository will load all of the ALC's/Lab's (Location's) data for the period into the Zero-Discharge System, copy the data files onto storage media, and distribute the updated ZDP to each ALC/Lab.

5. Maintenance Module

The Maintenance module includes three options: Backup Data Files, Reindex Data Files, and Maintain Lookup Data. The following paragraphs describe each of these options.

a. Backup Utility

The backup utility allows the user to make backup copies of the data contained in the databases. It is provided as a safety measure in the event of data loss to the system. The backup utility allows the user to select or manually enter the names of the files to backup. This utility uses the backup routine for MS-DOS 5.0. If the user has a later version of MS-DOS, the backup must be performed external to the ZDP application.

b. Reindex Utility

The reindex utility is used to reindex the databases when modifications (inserts, updates, or deletions) have been made to the data files. It is provided as a safety measure to ensure that the Foxpro index files are kept in synchronization with the database files. This utility should be run each time modifications have been made to the data.

c. Maintain Lookup Data

The Maintain Lookup Data option allows the user the flexibility to modify the data contained in the Location and Process lookup data files. As new locations and processes are added to the ZDP, the data in the appropriate files also need to be added. Any time a change is made to the lookup data files, the Chemical Constituent, Project, and Waste Discharge database files should also be modified to reflect the change. The functionality of the maintain lookup data screens is very similar to the Manual Input/Edit screens. The user has add, delete and edit options available.

6. Reports Module

There are ten reports in the Reports module for the ZDP. They are Combined ALC Progress Summary, ALC Progress Summary, Combined ALC Specific Waste, ALC Specific Waste, Current Project Summary, Individual Project Information, Summary of Project Information, Projects by Chemical Constituent,

Minimization Road Map, and Plan Description Report. Some reports are displayed in graphical format, while others are displayed in textual format. The different types of graphical reports are stacked bar charts, bar charts, and pie charts. For each report selected from the Report Menu, the user must also select the year of the data for which they wish to have the report generated. Each report automatically displays to the screen and may also be printed.

a. Combined ALC Progress Summary Report

The Combined ALC Progress Report displays the total waste quantities stored for all of the ALCs. This report is comprised of three graphs. The first graph is a stacked bar chart showing the annual waste discharge from each ALC by year over a 10-year period. The second graph is a bar chart showing the annual waste discharge from each ALC for the selected year. The third graph is a pie chart, which also shows the annual waste discharge from each ALC for the selected year.

b. ALC Progress Summary Report

The ALC Progress Summary Report displays the total waste quantities for the selected ALC. This report is comprised of one graph and a printed report. The graph is a bar chart showing the annual waste discharge from the selected ALC by year over a 10-year period. The textual report shows the annual waste discharge and the annual disposal costs by process for the selected ALC and year. The total waste quantities and total disposal costs are calculated and shown on the report. The total waste quantity corresponds to the total waste quantity on the bar graph for the selected year.

c. Combined ALC Specific Waste Report

The Combined ALC Specific Waste Report displays the total waste quantities for a selected process for all ALC locations. This report is comprised of three graphs. The first graph is a stacked bar chart showing the annual waste discharge for the selected process from each ALC by year over a 10-year period. The second graph is a bar chart showing the annual waste discharge for the selected process from each ALC for the selected year. The third graph is a pie chart which also shows the annual waste discharge for the selected process and year.

d. ALC Specific Waste Report

The ALC Specific Waste Report displays the total waste quantities for a selected process and ALC. This report is comprised of one graph and a textual report. The graph is a bar chart showing the annual waste discharge from the selected process and ALC by year over a 10-year period. The textual report shows the annual waste discharge and the annual disposal cost for the selected process, ALC, and year. The total waste quantity and total disposal cost is calculated and shown on the report. The total waste quantity corresponds to the total waste quantity on the bar graph for the selected year.

e. Current Project Summary Report

The Current Progress Summary Report provides a summary of the projects funded for the selected year and ALC. The expected cost and expected benefit are listed by project and process.

f. Individual Project Information Report

The Individual Project Information Report provides specific information for all projects within a selected ALC. The information displayed is the project name, expected cost, expected benefit, percent reduction of total, and payback period. Additional information for any project may be obtained in a textual report by selecting the desired project name. The additional information shown is the project start date, the funding source, project description, contact names, phone numbers and extensions, a flag indicating whether the project is research and development, and the project completion date.

g. Summary of Project Information Report

The Summary of Project Information Report provides the capability to select project summary information by process or by ALC. When a specific process is selected, the system displays a summary of the project information for the projects at all of the ALCs and labs that will reduce the wastes discharged by that process. The summary includes the ALC name, the project name, expected cost, and expected benefit for each project.

When a project is selected from the ALC option, the system displays the project name, process name, expected cost, expected benefit, the percent reduction of total wastes for that ALC, and payback period.

h. Minimization Road Map Report

The Minimization Road Map Report provides the capability to select waste minimization information for a selected process or chemical constituent for all ALCs or a selected ALC. The project name, status, ALC name, payback period, and total cost are displayed. The report summarizes the projects of a specific type and provides the opportunity to see what efforts are being made in a given area. The information can be used to prioritize future efforts.

i. Projects by Chemical Constituent

The Projects by Chemical Constituent Report lists all projects that pertain to a selected chemical constituent. The report shows the process name and project name for each project.

j. Plan Description Report

The Plan Description Report displays the Plan Objectives and Problems/Solutions of the Zero-Discharge Plan. These sections can be modified to fit the audience for a particular briefing and the results printed using this report.

7. Help Facility

In addition to the named modules, a help facility is also available throughout the entire system. The Help facility may be activated from within any screen or menu. The Help facility provides a general overview for each specific section and level (i.e., Combined ALC, Specific ALC, Process, and Chemical Constituents) for the entire system.

E. SYSTEM HARDWARE REQUIREMENTS

The Zero-Discharge Plan requires an IBM compatible personal computer with a 386 processor that operates Microsoft Windows 3.1 for DOS. It requires 6 megabytes of random access memory and 10 megabytes of hard disk space.

The "presentation machine" should have some additional capabilities beyond those of the operating computer. The system will run faster and more efficiently on a machine with a larger processor and more memory. The presentation machine must be an IBM compatible personal computer with a 486 processor that operates Microsoft Windows 3.1 for DOS™. It must have 10 megabytes of random access memory and 10 megabytes of hard disk space. Optimizing the memory through Windows is recommended.

SECTION IV
PHASE II DATA COMPILATION

A. INTRODUCTION

In parallel with the effort to develop the full-scale ZDP software, hazardous waste and project information were collected to provide the data necessary to operate the system. Personnel at the five Air Logistics Centers (ALCs) were contacted to obtain their waste discharge and project information. Letters were sent to the five ALCs detailing the type of information needed and requesting assistance in obtaining the data. Calendar year 1992 waste discharges and current waste-elimination project descriptions were requested. Some ALCs were visited by project personnel to assist in gathering the necessary information. The other ALCs were contacted by phone and mail correspondence, and after some time, the data were eventually sent through the mail on computer diskettes.

One problem encountered in attempting to gather the waste discharge information from the five ALCs was that the task of collecting data for this project was not considered a priority by some of the busy personnel at the bases, who had neither the time nor the desire to help us, because of their own pressing projects. As a result, the data obtained were erratic and disorganized and failed to contain some very important information. Thus, the time taken to gather and reduce the data was considerably more extensive than originally planned.

1. ALC Data Description

a. Waste Discharge and Chemical Constituent Information

Data obtained from the five ALCs were in vastly different formats and in a variety of conditions. Most of the ALCs employ several different software and computer systems to track their hazardous waste discharge information. Some information provided by the ALCs was only on hard copy and additional information had to be requested and tracked down. For all of the data sets, links had to be found between the different systems in which the data were contained to arrive at a complete set of information. Considerable ALC assistance was required to determine what links could be made and to locate additional information. Very few of the data sets linked wastes to processes, critical information for the ZDP. Going into the data sets and adding that information to the record for each waste container was time consuming. When all of the necessary information had been collected, the data sets were standardized to meet the requirements of the database system.

b. Project Information

Project data obtained from the ALCs and elsewhere, typically followed the same general format. However, only one ALC had this information on disk; all of the others were in hard copy form, so that the information had to be extracted by hand. Most of the project descriptions lacked much of the information required for the database, including cost, benefits, the expected reduction of discharged waste, and the chemical constituents targeted. These issues made assembling and standardizing the data a formidable task, and many records remain incomplete.

2. Assumptions Made in Data Reduction Process

An effort was made to standardize the data so that it would be uniform throughout. To do this, the first data set available to project personnel, the waste discharge information from Oklahoma City ALC (OC-ALC), was used as a basis. The wastestreams were grouped and consolidated based on assumptions concerning their origin and similarities. A list of 90 different types of wastestreams was produced and used in standardizing data from the other ALCs. As other ALC's data were reduced, this list was increased to 103 different wastestream groupings. A description of each wastestream was written into a file called WAST_DES.DBF in which basic assumptions made in grouping the wastestreams together are listed. These waste descriptions are used in the Zero-Discharge database Waste Discharge tables.

Process links were rarely provided in the existing data, in which case assumptions about the generating process were made based on the waste type, location of generation, provided process codes, and other information contained in the data sets. The determination process was one of gathering the information from existing data provided by the ALCs. Some bases were contacted about their lack of process links and eventually provided this information. The process codes used for the purposes of this database are published in the "Air Force Hazardous Waste Management Guide," November 13, 1992, page 15-31.

B. ALC WASTESTREAM AND CHEMICAL CONSTITUENT DATA

1. Oklahoma City Air Logistics Center

Data obtained from personnel at OC-ALC consisted of several different database files. One of the files, HAZW, contained a variety of useful information on an individual drum basis. One of the important fields that it contained was a basic description of the waste stream, called HW_MATERIAL. A decision was made to use this data set as the standard for all of the ALCs. In order to standardize these data, the HW_MATERIAL field was copied into a new database file called HAZSORT and three additional fields were created to include a wastestream number, process code, and a common name. Using this file, the wastestreams listed in the HW_MATERIAL field were grouped and consolidated and assigned a number. Misspellings, different punctuation usages, and multiple names made this a formidable task. The list was consolidated as much as possible and grouped into 90 different wastestream categories from an original list of 5062 records. This list was expanded to 103 categories to include different wastestreams found at the other ALCs.

Since no processes were included in the available data, a list was printed from HAZW showing fields containing information about the supervisor, building, and user organization of where the waste was generated. After discussing the lack of process links with personnel at OC-ALC, the previously list was faxed to them. They were asked to fill in, where possible, the process code for each wastestream listed, based on the supervisor and location of the building where the waste was generated. After several weeks, this information was sent back to us with the wastestreams linked to a process. This information was then manually input into HAZSORT in the PROCESS_NO field.

After all of the wastestreams and every record had been assigned a process code, a common name was assigned for each different wastestream category. For example, the wastestream category 3 consisted of various types of oils, such as engine oil, motor oil, refrigeration oil, and lube oil. This entire grouping of various oils was assigned the common name of "Oil." The file was then linked back to the HAZW file so that the waste discharge and chemical constituent table could be compiled. The expanded list of 103 wastestream groupings was then used as a standardized wastestream list for all of the other ALC's wastestream data.

An additional OC-ALC waste discharge data set, MANIF.DBF was considered after the initial set had been reduced. After reducing this new file, the two tables for both the WAST_DIS and CHEM_CON tables were appended together and resummed to complete the file.

a. Waste Discharge Table

The files HAZSORT and HAZW were copied to a working directory and HAZW was renamed TINK4 and modified to include necessary fields. TINK4 was then updated by replacing COMMON_NAME, WASTRM_NO, and PROCESS_NO from the HAZSORT table using the HW_MATERIAL field as the key. Five records did not have a match to the HW_MATERIAL field and therefore did not get updated. The process codes used in the HAZSORT table were updated in TINK4 to show the complete process name. Pertinent information from HAZW was entered into TINK4, including recycle information. The table was then summed for the quantity of waste and the total cost of waste disposal and selected into the WAST_DIS table. Field names were changed to comply with the standard format of the database system.

One problem encountered in this initial data set dealt with some of the cost information. Unit and total costs were listed for each record. However, some of these costs were listed as zero, which we assumed was incorrect. When summing up this file for the final waste discharge table, the total cost and quantity fields were summed for each unique combination of wastestream and process. The unit cost for each combination of wastestream and process name was then calculated as the sum of the total costs divided by the sum of the quantities. Those wastestreams that had initially listed a unit or total cost of zero and matched with no other wastestream or process group ended up giving a unit and total cost of zero in the final waste discharge table.

The reduction procedure for the additional waste data, contained in the file MANIF.DBF, was similar to that of the initial data set. Wastestream names, chemicals, and processes were extracted from the data according to the method previously described. However, no cost information existed for this data set. To remedy this problem, a list was printed from the previous data's final waste discharge table showing the wastestream, process, and calculated unit cost. Once wastestream names and processes had been assigned to each record in the new data set, the unit cost shown on the list was used for matching combinations of wastestream and process names. The total cost was calculated using this unit cost and multiplying by the quantity of waste. The table was then summed in the manner previously described. The cost figures developed in this manner are rough estimates at best. The actual costs for the disposal of these wastes are based on a pickup fee, a

transportation fee and a final disposal fee. Project personnel were unable to obtain this information for inclusion in the database.

b. Chemical Constituent Table

OC-ALC supplied two files that contained the results of characterization analyses performed on the hazardous waste that was to be shipped off site for disposal. These two files listed, by HW_NUMBER, the chemical constituents of the wastestream corresponding to that number. The files, HAZMACRO and HAZMICRO, were copied into a working directory and were edited to conform to a standard list. They were then appended together, creating a file containing 6114 records. Appropriate fields were added to the combined file and updated with the correct wastestream and process names from HAZW based on the HW_NUMBER that was common to both files. The quantity and cost were summed for each unique wastestream, process, and chemical constituent, creating the CHEM_CON table.

Chemical constituents for the MANIF file were extracted from the WASTE_DES field, a memo field containing limited descriptive information about the wastestream comprising that record. The chemicals were entered into a newly created field called CHEM_CONST and separated by semicolons. These chemicals were then parsed out into separate records using a locally generated utility called PARSCHEM. The quantity and total costs were summed according to wastestream, process, and chemical constituent, thereby completing the CHEM_CON table for the MANIF file.

2. Sacramento Air Logistics Center (SM-ALC)

a. Waste Discharge Table

Wastestream data for 1992 obtained from personnel at SM-ALC consisted of two data files, 92-1348.DAT and 92TURNIN.DAT, which were in ASCII format. The only pertinent information contained in these files was the quantity of waste and the total cost. Waste information for 1993 was received in Excel format in the files MAY.XLS and MIDNOVST.XLS and contained more complete information such as the process, the wastestream, and the hazardous constituents and indicated whether the waste was recycled. Both the 1992 and the 1993 files contained a field called the MCAFB that was either a series of four numbers followed by a letter or the letter "E" followed by four numbers. Using these numbers, the 1992 data could be linked to the 1993 data providing information regarding the wastestream, process, hazardous chemicals present, and the wastestreams recyclability. The letter found at the end of the MCAFB number represents the revision level. To link the two files, the letters had to be stripped off to make the numbers uniform between the two files. This was done in a field called MCAF, created for this purpose.

The files MAY.XLS (1180 records) and MIDNOVST.XLS (741 records) were then converted into FoxPro format and the MCAF field described above was created and filled. These two files were then merged into one file called 93WASTE.DBF by selecting records from MAY, where the MCAF number was not found in the MIDNOVST file. This selection consisted of 567 records, giving 93WASTE.DBF 1308 records in all.

The 1992 data file 92-1348.DAT was loaded into FoxPro, after using the KEDIT text editor and inserting commas to delimit the MCAFB, QTY,

and COST fields. The table format was modified to eliminate unnecessary fields and to create an MCAF field that was filled as previously described.

A new table, 93WASTES.DBF, was created from 93WASTE.DBF that contained only MCAF numbers that were in the 92-1348.DBF table. PROC_NAME, WAST_STRM, and CHEMICALS fields were created. Appropriate values for the WAST_STRM field were determined based on the Tinker standardized list of wastestreams and information contained in the existing CHARACTER field. Determination of the PROC_NAME was accomplished with the aid of information contained in the fields PROCESS and SOURCECODE that existed in the original MAY and MIDNOVST files and from the WAST_STRM field previously determined. Often the SOURCECODE field contained the two letter process code devised by the Air Force, in which case that was used as the process name. The CHEMICALS field was filled by combining the CHARACTER and CHARACTER2 fields that existed in the MAY and MIDNOVST files.

Another new table, NOTIN93.DBF, was created from 92-1348.DBF that contained only MCAF numbers that were not in the 93WASTE.DBF table. This table consists of 62 records from 1992 that have no link to the 1993 data and thus no information concerning the wastestream, process, chemicals, and recyclability. Personnel at SM-ALC were contacted concerning these records, but no additional information has yet been supplied.

The table 92WASTE.DBF was created from 92-1348.DBF and the following fields were made: PROC_NAME, WAST_STRM, LOCATION, CHEM_CONST, YEAR, and CHEMICALS. The values for the PROC_NAME, WAST_STRM, and CHEMICALS fields were replaced with values from the 93WASTES.DBF table. LOCATION was filled with "SM-ALC" and YEAR with "1992".

92WASTE.DBF was then summed into a new table WASTE_DIS.DBF for the fields QTY and COST, grouping by PROC_NAME and WAST_STRM, amounting to 178 records. The fields RECYC_FLAG, UNIT_COST, and DESCRIP were created to complete this table. Recycle information was determined from the DISPOSAL fields in the MAY and MIDNOVST files, the UNIT_COST was calculated as the COST field divided by the QTY field, and the DESCRIP field was linked with the WAST_DES file. The WASTE_DIS.DBF table was then ready for loading into the Zero-Discharge database.

b. Chemical Constituent Table

Creation of the chemical constituent table required use of the 92WASTE.DBF file. A manual editing effort was made to delimit particular chemicals with semicolons from text information in the CHEMICALS field. A reference list of chemicals that are to be tracked in the system would be useful in this step. The only text that remained in the CHEMICALS field was chemical names separated by semicolons. All other text in the CHEMICALS field was eliminated.

A table called 92CHEM.DBF was created by running a utility program designed to parse out the chemicals separated by semicolons in the CHEMICALS field and create a new record for each chemical listed. This routine produced 1174 records. The chemical names were then edited to conform to the approved list of chemicals being tracked. Special attention was necessary to ensure that only one spelling or form of the chemical existed in the 92CHEM.DBF table.

Another new table, CHEM_CON.DBF, was created with the sums of the QTY and COST grouped by PROC_NAME, WAST_STRM, and CHEM_CONST, giving 774 records. The table structure was modified as appropriate and was then ready for loading into the Zero-Discharge database.

3. Warner Robins Air Logistics Center (WR-ALC)

Data provided by personnel at WR-ALC consisted of information taken from a Hewlett-Packard database system, which tracked waste generated at the base, and another data set from a Lotus 123® spreadsheet program, which tracked accounting information for the wastes. Also included was a copy of some waste profile sheets (on hard copy only) which gave additional details of the wastestreams based on a profile number.

After discussions with personnel in charge of the two different tracking systems, the differences between the Hewlett-Packard database system and the Lotus 123® accounting system were determined to be the following:

- Until October 1992, the Hewlett-Packard system did not track the billing information on the drums of waste. All accounting information was done on the Lotus system.

- The Hewlett-Packard system tracked the waste prior to shipping it off-site. Thus, the final disposal weight was not known. The Lotus system kept track of the final disposal weights.

- Until October 1992, the Hewlett-Packard system did not track wastes that came from the base (Operations & Maintenance). That information is only on Lotus. Thus, Lotus carries both plane overhaul operations and Operations & Maintenance wastes.

- Some industrial wastes, particularly from the paint stripping operation, are only on Lotus (paint wastes, 500-900 lbs. from Bldg. 54, Clin = 5000+). Lotus is also the only system where excess and expired shelf-life materials are tracked.

- The analyses in Lotus may be somewhat abbreviated as compared to the Hewlett-Packard, but they were good enough for this project's approximations.

Based on this information, project personnel decided that use of the Hewlett-Packard system would be unnecessary, because the Lotus system contained all of the same information that the Hewlett-Packard had, and more, and would be sufficient for the project's needs.

a. Waste Discharge Table

Waste discharge data for 1992 from the Lotus accounting system was contained in six Lotus files: HWD1Q92.WK1, HWD2Q92D.WK1, HWD2Q92O.WK1, HWD3Q92.WK1, HWD4Q92D.WK1, and HWD4Q92O.WK1. To prepare these for loading into FoxPro, they were first converted to Excel file format, which made it

easier to manipulate them in preparation for conversion to database format. They were then imported into Foxpro and combined into one file called WORK.DBF.

The WORK.DBF file was modified by entering field names and increasing field widths where necessary. Unnecessary fields were eliminated. New fields were created including: RECYCLE, PROC_NAME, CHEMICALS, CHEM_PROF, and WASTE_STRM fields. Cost information in all of the files was determined to be the total disposal cost of that container of waste. Based on information contained in the LAB_ANALYSIS field, a wastestream name was extracted using the standardized list created for OC-ALC's wastestreams. Based on the assigned wastestream name, the process name was extracted. Where the lab analysis results did not fit into any category from the standardized list, the process or wastestream was assigned to the MISCELLANEOUS category.

In the chemical field previously created, all chemicals mentioned in the lab analysis field were listed, separated by commas. Some records had no constituents listed. Next, through review of the profile number listed, any chemicals mentioned in the profile sheets from WR-ALC were listed in the field created as CHEM_PROF. Only chemicals which did not appear in the CHEMICAL field were listed in the CHEM_PROF field. Files HWD4Q92D and HWD4Q920 did not have any profile numbers listed, thus no CHEM_PROF field was generated for these two files.

A "Y" for yes was inserted in the RECYCLE field for profile numbers listed as "recy" in the DISPOSAL field of the summarized file. A "Y" was also used for wastes such as freon, oil, hydraulic fluid, isopropyl alcohol, trichloroethane, and PD-680.

The fields COST, QTY_POUNDS, PROC_NAME, and WASTE_STRM were selected into a temporary table (TEMP.DBF) where the COST and QTY_POUNDS fields were summed for each unique process and wastestream. The data was then moved to table WAST_DIS.DBF. The fields YEAR and LOCATION were replaced with '1992' and 'WR-ALC'. The field UNIT_COST was calculated by dividing TOTAL_COST by QTY_WASTE and the DESCRIP memo field was updated by a search and replace routine where waste descriptions were inserted for each unique record from the WAST_DES file.

b. Chemical Constituent Table

A program was used to parse out the chemical names in the combined file, WORK.DBF. The fields CHEMICALS and CHEM_PROF were both parsed for chemical names. Minor changes had to be made to make parsing possible, such as the chemical name '1,1,1 TRICHLOROETHANE' was replaced with 'TRICO' before running the parse routine so that the commas would not interfere with the program. The records were multiplied into another file TEMPWORK.DBF with one chemical name for each process and wastestream name.

The data were then selected into the CHEM_CON.DBF file and the COST and QTY_POUNDS fields were summed for each unique process, wastestream and chemical. Chemical names were standardized again to eliminate abbreviations.

4. San Antonio Air Logistics Center (SA-ALC)

a. Waste Discharge Table

Waste discharge data from SA-ALC came in two Excel files, called WASTELST.XLS and TWCCODE.XLS, and a hard copy of a file that contained disposition information. These were imported into Foxpro to facilitate preparation of the waste discharge table. Using WASTELST, the fields YEAR, LOCATION, PROC_NAME, WAST_STRM, and RECYCLE were created. Wastestreams were extracted using information contained in the NOUN field, after which process names were determined based on the wastestream and the NAME OF WORKCENTER field. Recycle information was determined by looking at the disposition documentation. The COST and QTY fields were summed for each unique process and wastestream and the necessary fields were selected into a WASTE_DIS.DBF file. The year was filled with "1992", the location was set to "SA-ALC," and UNIT_COST was calculated as the COST divided by the QTY, thereby completing the waste discharge table.

b. Chemical Constituent Table

Chemical names were extracted from information contained in the TWCCODE file into two newly created fields called CONSTIT_1 and CONSTIT_2. The chemical constituent table CHEM_CON was made by linking the wastestreams and process names from WASTE_DIS with the chemicals that were previously extracted. This linking was done based on the TWC_CODE number which was common to both files. The COST and QTY fields were then summed based on process name, wastestream, and chemical. The chemical constituent table was then ready for loading into the Zero-Discharge System.

5. Ogden Air Logistics Center (OO-ALC)

Personnel at OO-ALC failed to provide the necessary information to be able to include waste discharge for OO-ALC in the database. Some information was supplied very late in the project, but it was not appropriate for the database. Efforts are still underway to obtain that data and include it before the project ends.

C. Air Quality Utility Information System

The Air Quality Utility Information System (AQUIS) contains detailed air emission information directly tied to specific processes. Data applicable to the Zero-Discharge plan were formally requested from the Air Force personnel who operate the system for the Air Force Materiel Command at Wright Patterson AFB, followed by several informal telephone requests. No data have been received, leaving the ZDP totally deficient with regard to air emissions.

D. PROJECT DATA

1. Air Logistics Centers

Each ALC, except Ogden, submitted project data using the same general format, which consisted of a one-page narrative that included information such as: Title, Project Number, Cost, Current Process, New Process, Environmental Benefits, Maintainability/Reliability Benefits, Impact on Mission, Economics, Technology Transfer, and Point of Contact. Following

the format suggested for the Project Information table, necessary information was extracted from the aforementioned data to fill in the required fields. The four key fields in the Project Information table are Year, Location, Proj_Name, and Proc_Name. These fields are used for indexing the project data and are therefore required to be filled by the database system in order for it to function properly when performing sort and summing routines. Other fields in the table were left blank if the information could not be found in the narrative.

2. Department of Energy

Data for the Department of Energy (DOE) project table were obtained from information contained in FY 1993 Waste Minimization Field Project Task Description Documents (TDD) supplied by the DOE Office of Technology development through the DOE-AF Memorandum of Understanding (MOU). These TDD's consisted of several pages for each listed project in a format different from that used by the ALCs. After reading the information in the task description documents, the necessary information was extracted, where available, and manually input into the main project information table in preparation for loading into the database.

3. Air Force Laboratories

Project Data Sheets were obtained from the Wright Laboratory Operations and Support Directorate and were used for gathering project information for Wright-Patterson and Armstrong Laboratories. The format for these data consisted of a short one-to-two page summary of the project, along with a timeline approach sheet listing appropriate milestones, funding arrangements, and a project flow diagram. These data sources were used for extracting the necessary project information required in ZDP system.

E. DATA VERIFICATION/VALIDATION

1. Waste Discharge and Chemical Constituent Table Verification

While assembling the data for input into the waste discharge and chemical constituent tables, a careful documentation of all steps and procedures taken was made. These step-by-step routines were given to an independent verifier and used to retrace the steps taken to see if the tables could be reproduced and to ensure that no data had been lost in the process. The final waste discharge and chemical constituent tables were also checked to ensure that all of the process names, wastestreams, and chemicals were in a standardized form and that everything was spelled correctly.

2. Project Table Verification

Because project data received from the ALCs, DOE, and laboratories did not contain the necessary information in the required format for the ZDP database, almost all of the project information was manually entered. After entering all of the data for an individual ALC, the project summaries were double checked to ensure that all of the information had been entered correctly. Finally, chemical names were checked for validity and spelling and then standardized to correlate with those found in the waste discharge table.

SECTION V
RECOMMENDATIONS

A. SOFTWARE IMPROVEMENTS

Over time, the ZDP will accumulate a large amount of data, 20,000 to 30,000 records. Currently, the overall data volume is approximately 2,500 records. Because of some of the calculations the screens are performing, utilization of optimization routines is recommended to process data queries when the data volume significantly slows the system.

The automatic data load utility could be simplified by allowing the capability for the ZDP to load .dbf files into the system, rather than ascii files, which it now requires. Currently, the data must be in "exact" format in order for this utility to work properly. This was a requirement for the system because, regardless of the media on which the data are stored, an ascii file may be created to load the data into ZDP. Summarizing the data into the format expected by the ZDP is an additional step that must be performed on the data before it can be loaded into the system. Putting the files a into a database (.dbf) format would make loading the system much easier. The summarized files could then be appended into ZDP.

Depending on the system users, the Help section may require the addition of some more detailed explanations. This need may become apparent over time as more users are working with the system. However, the current Help facility may prove to be sufficient.

The percent reduction calculation is not a "true" percent reduction of the data contained in the database because there is no waste quantity reported at the project level. The percent reduced calculation is currently calculated at the process level for the selected ALC and year. When, and if, this data becomes available, the software should be changed to reflect the "true" reduction of waste quantities reduced by each project.

B. DATA-GATHERING RECOMMENDATIONS

Several recommendations have been developed in an effort to make the data reduction process less time-consuming and more efficient. As contact was made with personnel at the ALCs, they had little time to spare on a contractor-run project. Thus, the task of assembling and gathering the data was a low priority and received little attention, without constant urging and pressure. This problem greatly increased the length of time required to obtain adequate data. This problem may be curbed with the assistance of higher management. If the Air Force officer responsible for administering the ZDP could ensure that he had that management support, future data-gathering efforts should be easier.

Second, the Air Force has published a standard list of process codes as mentioned previously in this report. However, very few of the ALCs use it in tracking the processes responsible for generation of the wastes. The task of obtaining process links to the existing wastestream data was difficult and often required making some assumptions. If the ALCs could be convinced to adopt the process codes and employ them as part of their existing waste tracking system, the time needed to acquire this information in the first dataset could be completely eliminated for subsequent datasets.

A wastestream and chemical constituent standard pick list should be assembled and applied at each ALC to aid in standardizing the data. These lists would eliminate the problems of misspellings, multiple names, and dual usage. If such standardization were required at the base level, data acquisition for the Zero-Discharge Database would be significantly more efficient.

One change that would be difficult to implement would require the ALCs to keep all of their waste generation tracking data in the same standard format to eliminate the guesswork involved in deciphering how the multiple systems used relate to one another. Adoption of the Work Information Management System - Environmental Subsystem (WIMS-ES) Waste Discharge module or a similar system at the ALCs would standardize the information systems and make extraction of the ZDP data considerably more efficient.

Most of the ALCs maintained their project data on some sort of word processing system and simply printed out hard copies of the information to fulfill our request. McClellan AFB, however, tracked their project information on Microsoft Access™, a database system, which made the process of extracting necessary information much more efficient. This would be a good recommendation to all of the ALCs to follow since information stored in this manner is much easier to update and work with. Certain information, such as process and project descriptions, can be contained in its own field when using such a system. Full application of the WIMS-ES A106 and Pollution Prevention modules would put the data into a format that could be directly downloaded into the ZDP.

For future ZDP maintenance personnel, increased access to WIMS-ES and other existing Air Force waste tracking systems, such as AQUIS, would greatly improve their ability to obtain the necessary information. ZDP personnel should have direct access to these systems with the capability of electronically extracting any pertinent information found there.

Employment of these recommendations would increase the efficiency of future data-gathering efforts substantially, decreasing the time required and lowering the cost. These or similar changes should be implemented, if the ZDP is to ever be employed successfully.

SECTION VI
CONCLUSION

The Air Force trying to reduce their discharges of hazardous wastes. The goal of zero hazardous waste discharge may not be reached soon, but great strides can be made toward that goal with carefully planned and prioritized projects and efficient use of the budgets available to make the needed changes. The Zero-Discharge Plan will be one tool available for those responsible for planning, funding, and executing the changes. Its effective use in conjunction with such tools as WIMS-ES and AQUIS will assist the Air Force in selecting projects, allocating resources, and reaching their goal of zero discharge.